

REPORT DOCUMENTATION PAGE

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(include area code)
(661) 275-5015

a. REPORT

b. ABSTRACT

c. THIS PAGE

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A

Standard Form 298 (Rev. 8-98)
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13 separate items enclosed

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MEMORANDUM FOR PR (Contractor/In-House Publication)

FROM: PROI (TI) (STINFO)

17 Apr 2000

SUBJECT: Authorization for Release of Technical Information, Control Number: **AFRL-PR-ED-TP-2000-070**
Blanksi, R., Phillips, S., Chaffee, K.; Lichtenhan, J. (Hybrid Plastics); Lee, A. & Geng, H.P. (Michigan State University), "The Synthesis of Hybrid Materials by the Blending of Polyhedral Oligosilsesquioxanes into Organic Polymers"

Materials Research Society Meeting

(Statement A)

(San Francisco, CA, 24 Apr - 02 May 2000) (Submission Deadline: 02 May 2000)

1. This request has been reviewed by the Foreign Disclosure Office for: a.) appropriateness of distribution statement, b.) military/national critical technology, c.) export controls or distribution restrictions, d.) appropriateness for release to a foreign nation, and e.) technical sensitivity and/or economic sensitivity.

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Comments: _____

APPROVED/APPROVED AS AMENDED/DISAPPROVED

ROBERT C. CORLEY
Senior Scientist (Propulsion)
Propulsion Directorate

(Date)



The Synthesis of Hybrid Materials by the Blending of Polyhedral Oligosilsesquioxanes into Organic Polymers

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Lichtenhan², Andre Lee³, and Hei Ping Geng³.

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Hybrid Organic/Inorganic Blends

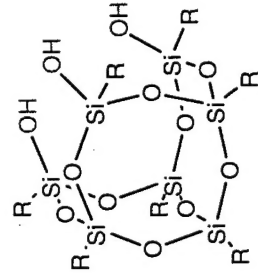
- GOAL: To study the interaction and solubility of Polyhedral Oligosilsesquioxane (POSS) molecules containing various organic side groups with the polymer matrix
- Polystyrene was chosen since it is readily available and can easily be solvent cast with the POSS molecules for TEM studies



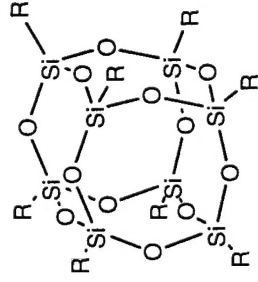
Why Use Blendables?

- Easier to tailor the organic side groups of the POSS molecule to give a polymer-soluble species
- Simple blending techniques can be used instead of copolymerization with reactive POSS monomers
- Potential Drop-in molecular modifier without requiring expensive replacement of processing equipment

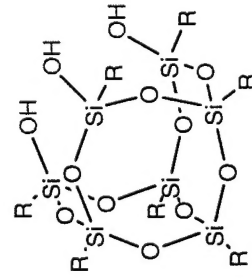
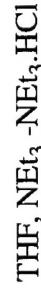
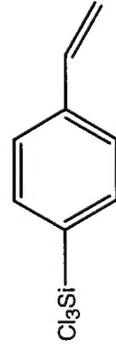
POSS = Polyhedral Oligomeric Silsesquioxane General Synthesis



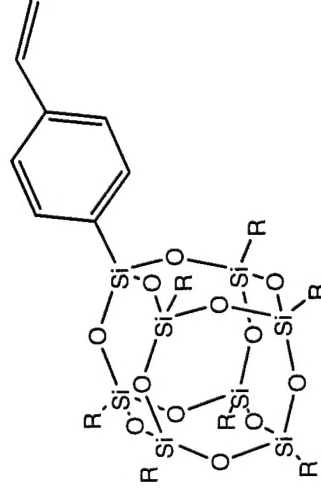
R = cyclopentyl
vinyl



R = cyclopentyl
vinyl



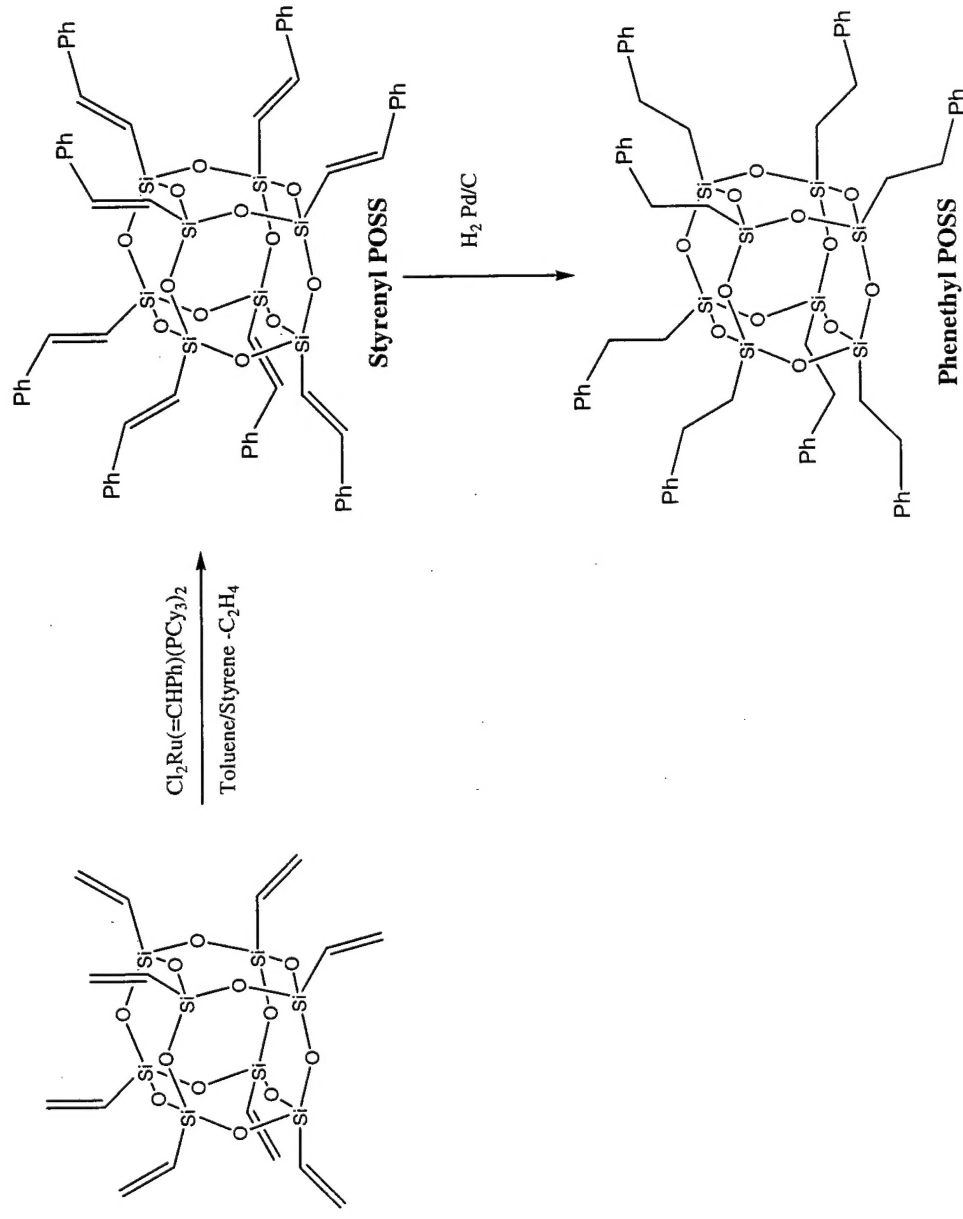
R = cyclopentyl



R = cyclopentyl

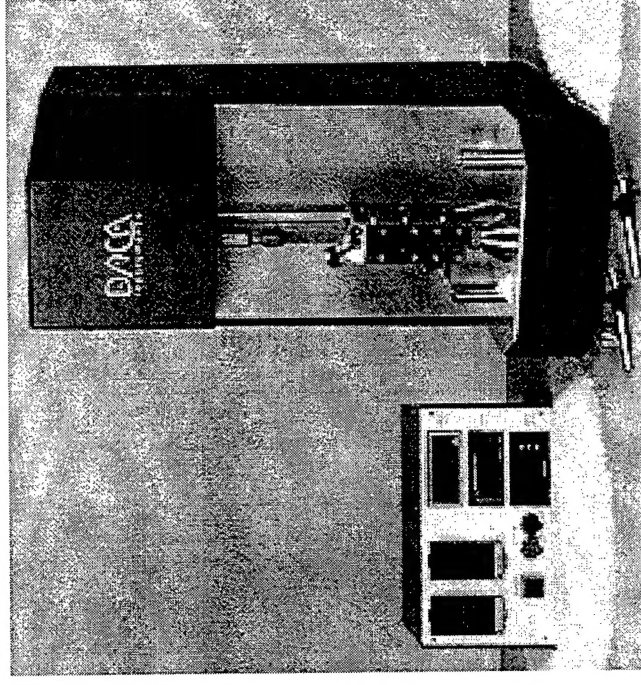
POSS = Polyhedral Oligomeric Silsesquioxane

General Synthesis



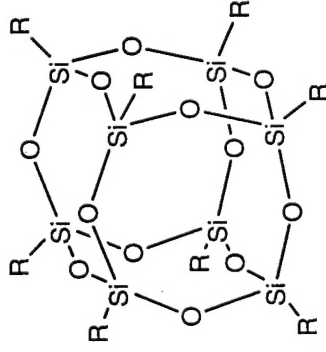
Preparation of Styrene-POSS Blends

- TEM Method
- Dissolve the Styrene and POSS in THF
- Cast very thin film by slow solvent evaporation
- Traditional Processing
- Place Polystyrene in Extruder
- Add POSS
- Blend 2-5 Minutes



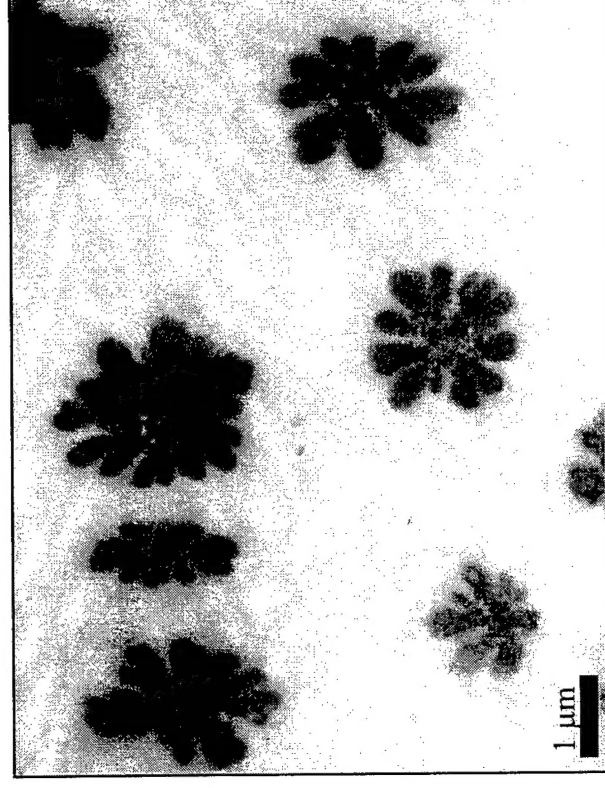
POSS Blends - Crystal Formation

50 wt % Cp_8T_8 in 2 million mol. wt. Polystyrene



R = cyclopentyl

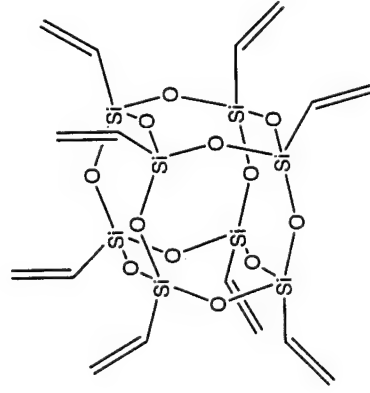
Cp_8T_8



TEM image clearly shows formation of immiscible POSS crystallites (20-50k molecules)

POSS Blends - Crystal Formation

50 wt % Vi_8T_8 in 2 million mol. wt. Polystyrene



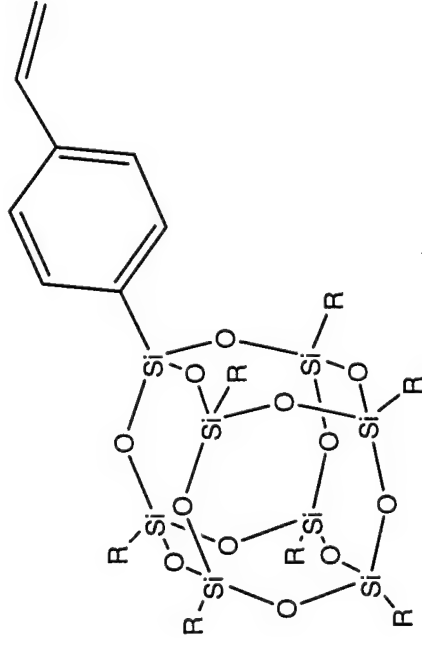
Vi_8T_8



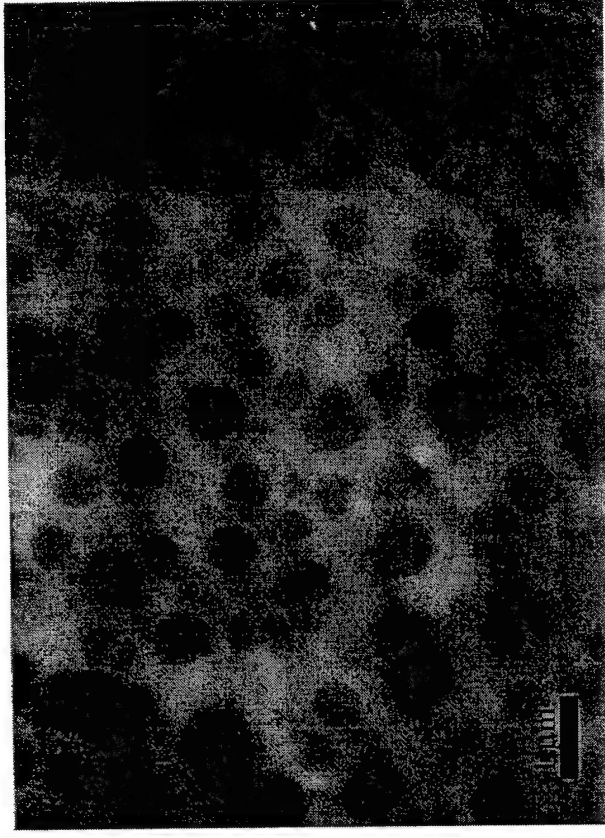
TEM image clearly shows immiscibility in polymer system

POSS Blends - Increased Solubility

50 wt % Cp₇T₈Styryl in 2 million mol. wt. Polystyrene



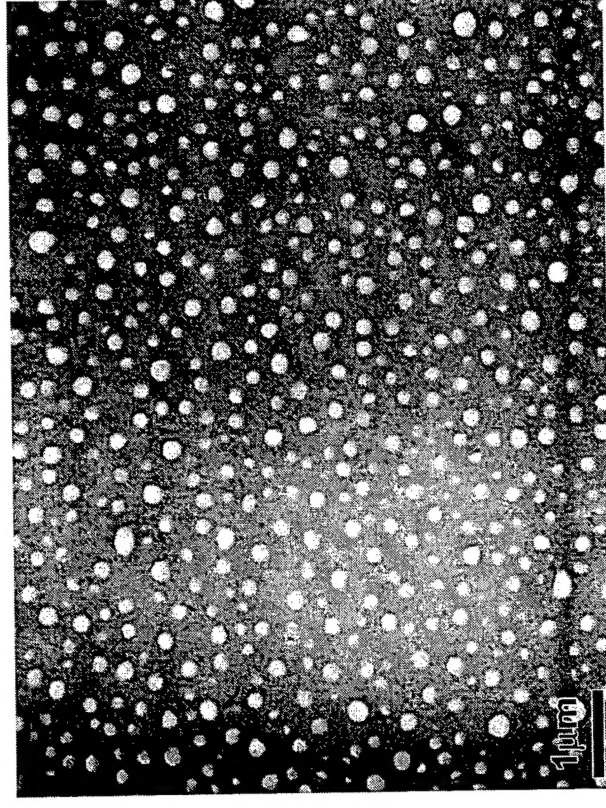
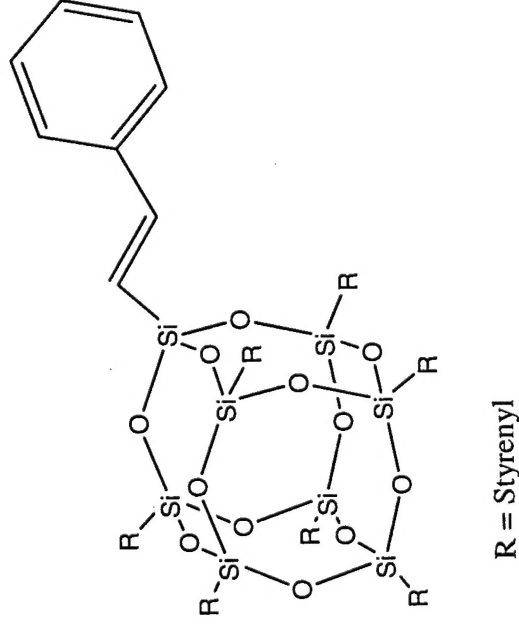
R = cyclopentyl



TEM image shows significant decrease in size of crystallites

POSS Blends - Miscibility

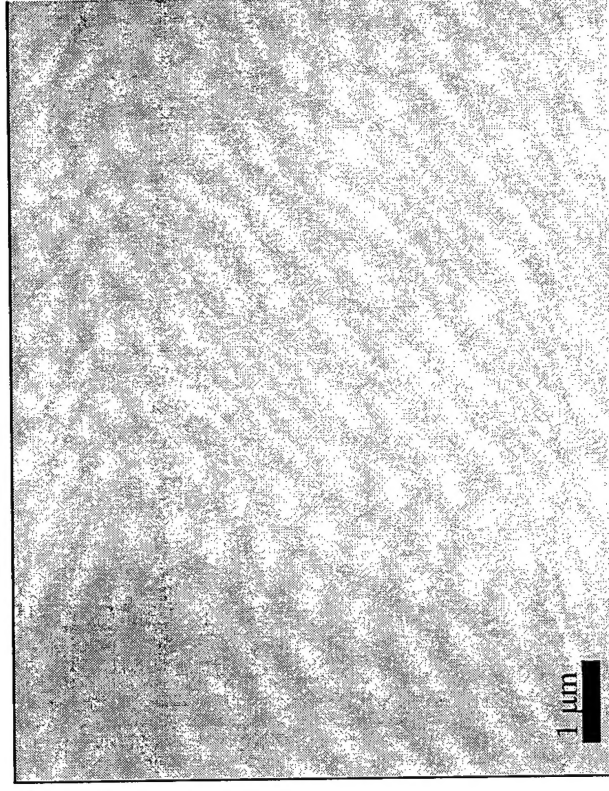
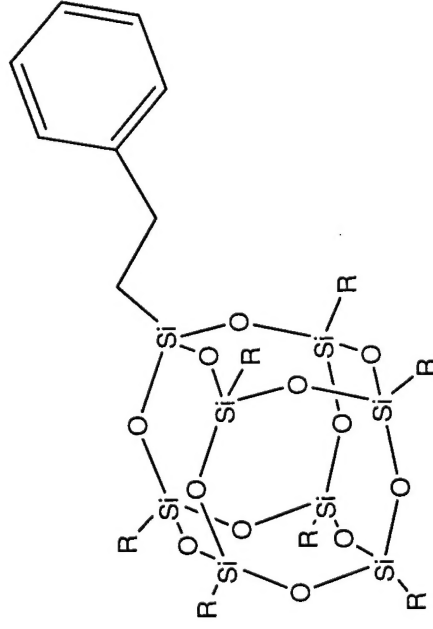
50 wt % Styrenyl₈T₈ in 2 million mol. wt. Polystyrene



- White domains represent pure polystyrene (process issue)
- Grey domains represent miscible POSS/polystyrene
- Black dots are POSS crystallites (<100 POSS molecules)
- 30% increase in surface hardness of the material

POSS Blends - Miscibility

50 wt % Phenethyl₈T₈ in 2 million mol. wt. Polystyrene



- **Demonstrated Complete Miscibility!!**
- **Grey domains represent miscible POSS/polystyrene**
- **Black dots are POSS crystallites (<100 POSS molecules)**



Conclusions

- The organic side groups on the POSS molecule are extremely important in determining the solubility of the POSS in polystyrene
- The addition of the more soluble styrenyl POSS into styrene leads to an increase in surface hardness without adversely affecting polymer properties
- POSS can be thought of as functionalized silicas with the side groups acting as solubility enhancers



Acknowledgements

- AFRL Propulsion Directorate
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- Dr. Charles Lee, AFOSR (Funding)